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The Taxonomy of *Diandranthus* (Poaceae)

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Diandranthus (Poaceae) was segregated from *Miscanthus* by Liou in 1997. Members of the genus have been reported from China, Nepal and India, with a disjunct occurrence in Malaysia. This paper presents a revision of the genus with a clarification and circumscription of the species and synonymy. The genus contains two species, *D. nepalensis* and *D. nudipes*. *Diandranthus nudipes* contains two subspecies: subsp. *nudipes* and subsp. *yunnanensis*, comb. nov. An identification key, descriptions of the taxa, and distribution maps for all taxa of *Diandranthus* are provided.

Key words: *Diandranthus*, distribution, Poaceae, *Miscanthus*, taxonomy.

Diandranthus L. Liou is a genus of large tussock grasses distributed from middle to high elevations in China, Nepal, India, and Malaysia. Members of *Diandranthus* have long been treated as belonging to *Miscanthus*, *Eulalia* or *Erianthus* (Trinius 1833, Grisebach 1868, Keng 1957, Bor 1960, Lee 1964, Zhong 1988).

The first attempt to distinguish the species of *Diandranthus* as a single group was by Keng (1957, 1959), when he grouped the Chinese members of the present *Diandranthus* as a section in *Miscanthus*. Since he published his new section without a Latin diagnosis the name is invalid. Liou (1987) distinguished *Diandranthus* from *Miscanthus* as a genus containing seven species. Liou (as Liu) did not indicate a type species for the genus until 1997, at which time the generic name became valid.

Diandranthus is closely related to *Miscanthus* and is distinguished from it by the number of anthers and the position of the stigmas. *Miscanthus* has three stamens and the stigmas exserted laterally from the spikelet; *Diandranthus* has only two stamens and the stigmas exserted apically. DNA data (Hodkinson *et al.* 1997, 2002) of *Diandranthus* and related taxa further show that *Diandranthus* is phylogenetically different from *Miscanthus*.

Since taxonomic studies of *Diandranthus* have been restricted to floristic or regional works (Hooker 1897, Bor 1960, Lee 1964, Liou 1987, Zhong 1988, Noltie 2000), there is no overall monograph of the genus. This revision, based on specimens from throughout the entire range of distribution, provides the first taxonomic account for all the species of *Diandranthus*.

Materials and Methods

This study is based mainly on herbarium material obtained on loan from the following herbaria (abbreviations according to Holmgren *et al.* 1990): BISH, BM, BSHC, E, GOET, K, P, PE and US. Specimens were also examined at KATH, KYO, MAK, PNH, TI, TNS, TUS and the Herbarium of Tamagawa University, Tokyo. Dots on distribution maps are based exclusively on the specimens studied.

A field survey was also carried out in Nepal.

The living plants and seeds collected in Nepal were grown and observed at the experimental facility of Tohoku University and in the garden of the Tokushima Prefectural Museum.

Pollen was obtained from herbarium specimens kept in the Biological Institute, Tohoku University, Sendai, Japan (TUS). Specimens utilized in this study are cited in Table1. For SEM observation, pollen grains were acetolysed following the standard method (Erdtman 1960) and dehydrated in an ethanol series. The samples were air dried and coated with gold in a vacuum, and examined with a scanning electron microscope (Hitachi S-4100). The axis length was determined from measurments of 25 grains in each sample.

One spikelet per inflorescence on each specimen of *Diandranthus nudipes* was selected to determine the length of the callus hairs and glume hairs.

To compare the range of variation between taxa, I chose and measured at least two spikelets and awns from each specimen of all taxa.

Thirty spikelets and their adjacent rachis internodes on the holotype of *Miscanthus wardii* (= *Diandranthus nudipes* subsp. *nudipes* in this paper) were chosen for length comparison.

Taxonomic characters

Habit. The species of *Diandranthus* are all tussock grasses, usually with many, erect, unbranched culms (Fig. 1). Liou (1987, 1994, 1997) used characteristics of culm branching as a taxonomic character, but I have not found it to be taxonomically useful. The specimen *H. Hara et al. no. 6302319* of *D. nepalensis* is branched at one node, and the culms of *D. nepalensis* cultivated at Tokushima Prefectural Museum occasionally branch. The height of the culm has also been used as a taxonomic characteristic in *Diandranthus* (Liou 1997), but height varies greatly even in the same species. For example, *D. nudipes* subsp. *nudipes* ranges from 20-140 cm in height, *D. nudipes* subsp. *yunnanensis* ranges from 50-150 cm, and *D. nepalensis* is 30-160 cm tall. Height is therefore not a useful taxonomic character.

Inflorescence axis. The length of the axis of the inflorescence has been used taxonomically (Keng 1959, Liou 1997), but the length of the inflorescence axis varies widely and continuously; 2-8.5 cm in *Diandranthus nudipes* subsp. *nudipes*, 2.5-10 cm in subsp. *yunnanensis* and 2.5-12 cm in *D. nepalensis*. I therefore did not use the length of the inflorescence axis as a diagnostic character in my treatment. As Liou (1994) indicated, the inflorescence axis of *D. nudipes* subsp. *nudipes* is usually pilose (Fig. 2a), while the axis of subsp. *yunnanensis* is glabrous (Fig. 2b).

Rachis. Bor (1960) separated *Miscanthus wardii* Bor from *Diandranthus nudipes* by the spikelets equaling or exceeding than the rachis internode. Fig. 3 shows the relationship between the length of the rachis internode and the length of its adjacent spikelet on the holotype of *M. wardii*. The figure shows that the rachis internode is usually longer than the spikelet. In all species of *Diandranthus*, however, the internode of the rachis is longer than, or at least as long as, the spikelet. I therefore did not use it as a diagnostic character in this treatment.

TABLE 1. Pollen size and shape of *Diandranthus* and *Miscanthus*.

Taxa	major axis ± SD (μm)	minor axis ± SD (μm)	major axis / minor axis	Voucher specimen
D. nudipes subsp. nudipes	29.0 ± 1.3	27.5 ± 0.9	1.05	*Naito et al. 1012* (TUS)
D. nepalensis	32.6 ± 2.0	29.7 ± 2.2	1.09	*Mikage et al. 9682755* (TUS)
M. sacchariflorus	36.7 ± 2.3	33.7 ± 2.0	1.09	*Yonekura 1147* (TUS)

FIG. 1. *Diandranthus nepalensis*. Several culms tuft ascending from bank at roadside (Nurbu Chaur, Eastern Nepal. alt. 2080m. 30 Aug. 1997).

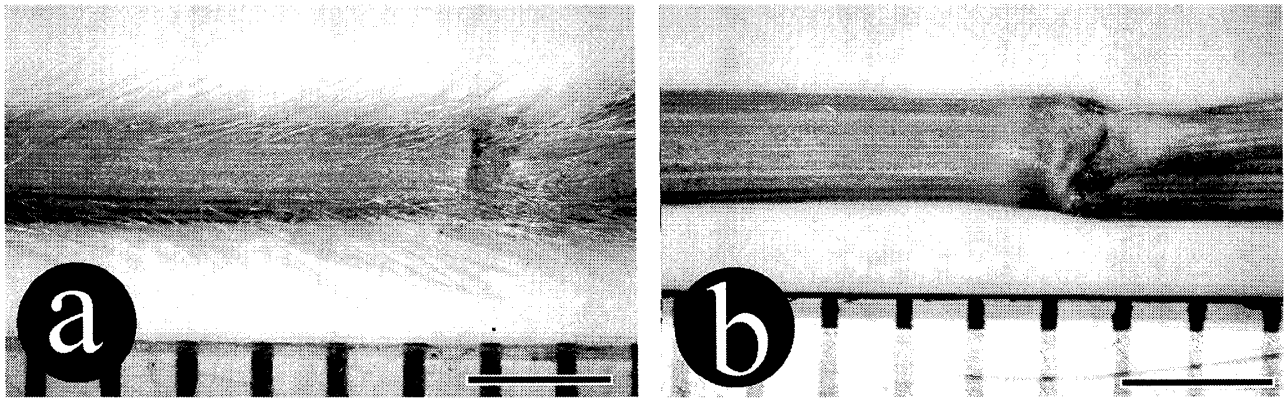

FIG. 2. Inflorescence axis of *Diandranthus nudipes*. a. subsp. *nudipes*, long hairs covering on the surface. b. subsp. *yunnanensis*, glabrous on the surface.

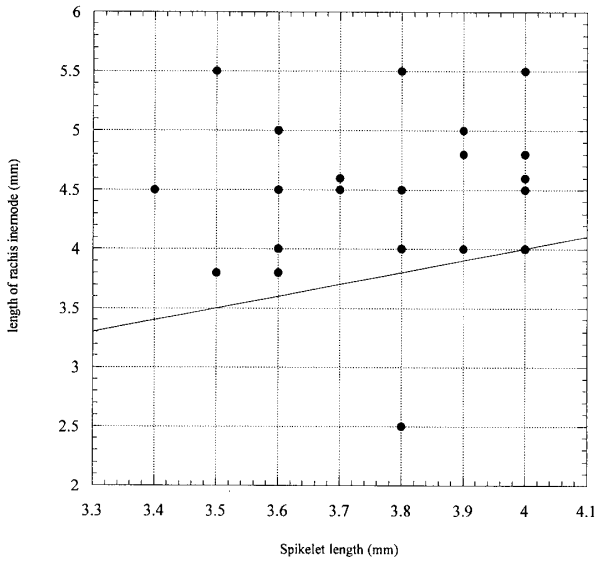

FIG. 3. Relationship between spikelet length and length of rachis internode on a holotype of *Miscanthus wardii* Bor (=*Diandranthus nudipes* subsp. *nudipes: Kingdon - Ward 19328*, K).

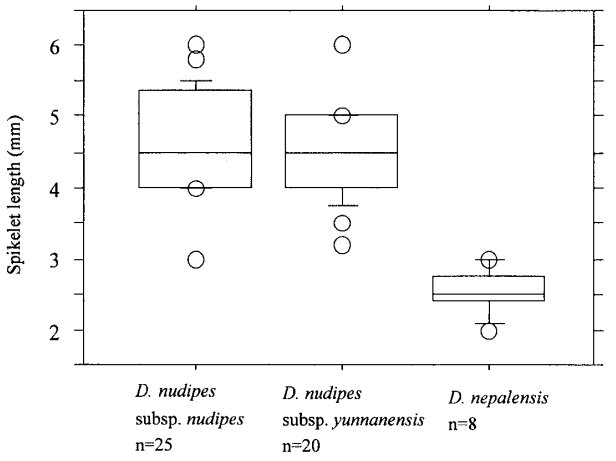

FIG. 4. Spikelet length variation in *Diandranthus*. The box encompasses the 25th - 75th percentile data interval, with the midline representing the median. The vertical bar represents the 10th-90th percentile interval; the dot represents a sample outside the interval. The means are not significantly different between *D.nudipes* subsp. *nudipes* and subsp. *yunnanensis* at $p < 0.05$ (Tukey-Kramer's multiple range test). "n" represents the number of spikelets.

Spikelet length. The length of the spikelet has also been used as a taxonomic character (Liou 1987, 1994, 1997). Fig. 4 shows a comparison spikelet lengths for all the taxa of *Diandranthus*. Although *D. nepalensis* tends to have shorter spikelets than *D. nudipes*, the length of the spikelets shows a wide range of variation and overlap between the taxa. It is impossible to divide all taxa using this character.

Callus hairs. The callus hairs at the base of the spikelets of *Diandranthus* have been used as a key taxonomic character (Liou 1987, 1997). The callus hairs of *D. nepalensis* are three times as long as the spikelet and make it easy to distinguish this species from the other taxa of the genus (Fig. 5c). Fig. 6 shows variation in the length of the callus hairs and glumes in *D. nudipes*. Although exhibiting a wide range of variation, the ratio of the length of the callus hairs and glume hairs as a diagnostic characteristic will usually distinguish subspecies.

Hairs on the glume. The pubescence of the glumes and the length of the hairs on the glume surface have been used as key characters in *Diandranthus* (Bor 1960, Liou 1987). The glumes of *D. nepalensis* are glabrous, while those of both subspecies of *D. nudipes* are pubescent (Fig. 5a-c). The density of the hairs on the glumes of *D. nudipes* varies widely and there is no discontinuity between the two subspecies. The lower glume in *Miscanthus wardii* Bor (= *D. nudipes* subsp. *nudipes* in this paper) and in *D. tibeticus* L. Liou (= *D. nudipes* subsp. *nudipes* in this paper) have been reported to be glabrous (Bor 1953, 1960; Liou 1987), but I have confirmed that they are abaxially hairy. Although the hairs of *D. nudipes* subsp. *yunnanensis* tend to be longer than in subspecies *nudipes*, there is wide variation and overlap between the two subspecies (Fig. 6); 1 - 3.5 mm long in subsp. *nudipes* versus 2 - 4.7 mm long in subsp. *yunnanensis*.

Awn. The length of the awn has been used as a taxonomic characteristic (Keng 1959, Liou 1987), but it varies widely and shows some overlap between species (Fig. 7). The spikelets of *Diandranthus* are usually awned , although the terminal spikelet occasionally has two awns (Fig. 8a). Similar variation is also found in the spikelets of *Miscanthus*

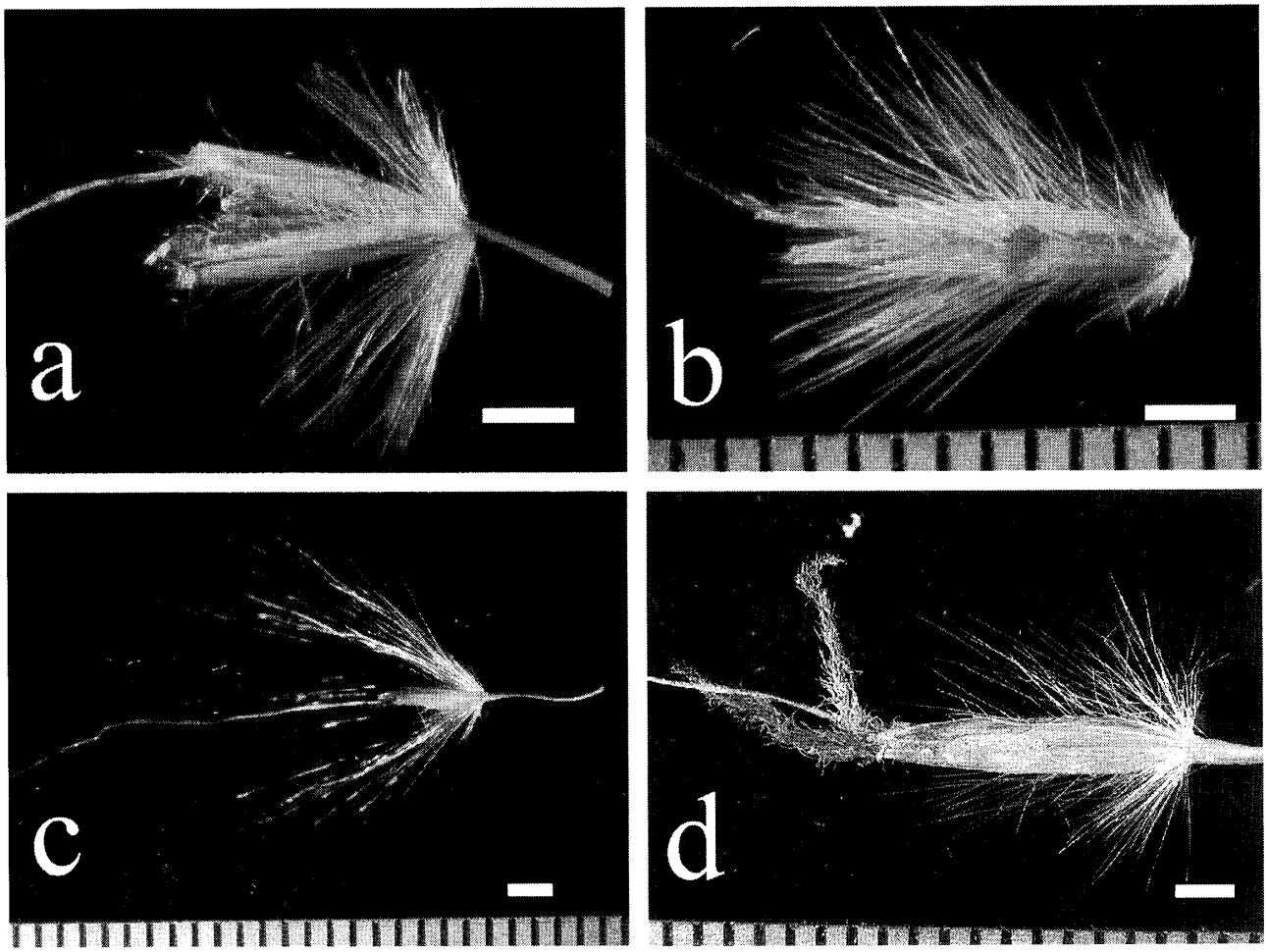

FIG. 5. Spikelets of *Diandranthus*. a. *D. nudipes* subsp. *nudipes* (*Hooker 10*, K). b. *D. nudipes* subsp. *yunnanensis* (*Maire annèe 1914* P). c. *D. nepalensis* (*Mikage et al. 9682755*, TSU). d. A spikelet of *D. nudipes* subsp. *nudipes* that have rather short callus hairs (*Kingdon-Ward 15024*, E). bar = 1 mm.

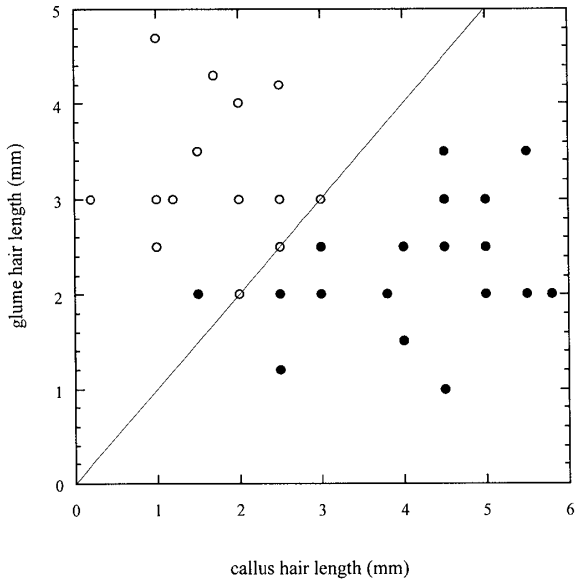

FIG. 6. Comparison of the maximum length of the callus hair and the glume hair of *Diandranthus nudipes* subsp. *nudipes* and subsp. *yunnanensis*. Solid circle: subsp. *nudipes*. Open circle: subsp. *yunnanensis*.

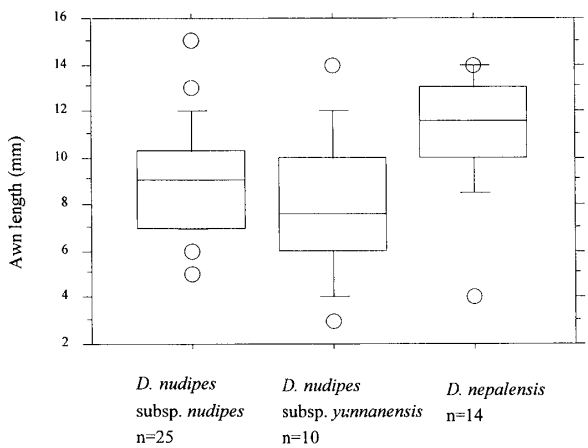

FIG. 7. Awn length variation in *Diandranthus*. The box encompasses the 25th - 75th percentile data interval, and the midline represents the median. The vertical bar represents the 10th - 90th percentile interval; the dot represents a sample outside the interval. The means are significantly different among *D.nudipes* subsp. *yunnanensis* and *D.nepalensis* at $p < 0.05$ (Tukey-Kramer's multiple range test). "n" represents the number of spikelets.

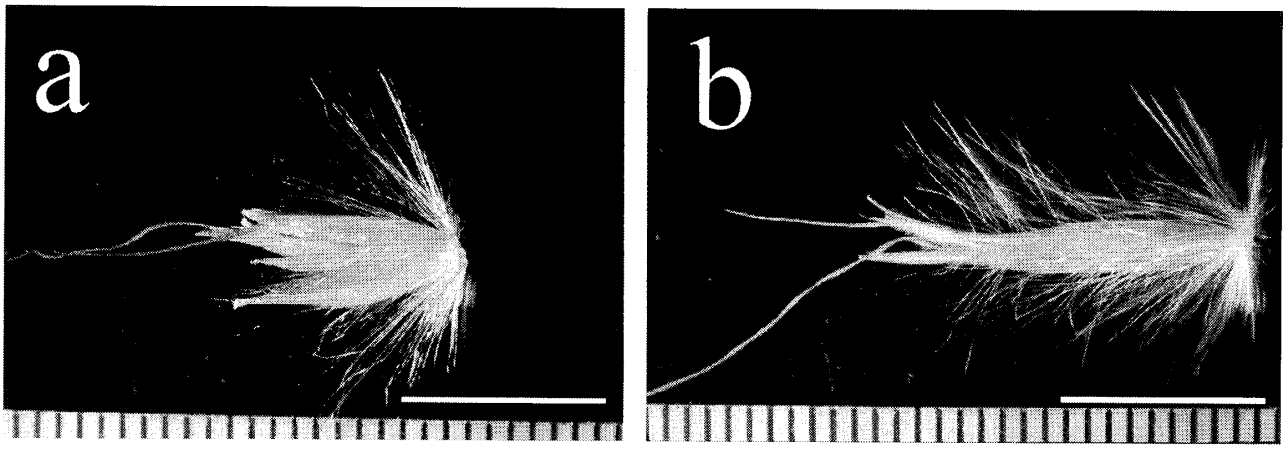

FIG. 8. The spikelet with two awns. This kind of unusual spikelets sometime found on the terminal of inflorescence raceme. a. *Diandranthus nudipes* subsp. *nudipes* (*Nakao 734*, KYO). b. *Miscanthus oligostachyus* (*Yokoyama et al. 97104070*, TUS). bar = 5 mm.

(Fig. 8b). Liou (1994, 1997) used awn length to distinguish *Diandranthus aristatus* L. Liou (= *D. nudipes* subsp. *yunnanensis* in this paper) from congeners. However, I consider awn length to be variable and not useful as a diagnostic characteristic in *Diandranthus*.

Pollen. The pollen grains of *Diandranthus* are globose, monoporate and with granulate sculpturing (Fig. 9a-f), as generally seen in Poaceae (Acedo 1999). The pollen of *Diandranthus* shows no specific diversity in morphology and is of nearly uniform, same size among the species (Table. 1). The pollen grains of *Miscanthus* are similar to those of *Diandranthus* (Fig. 9g-i).

Taxonomic treatment

Diandranthus L. Liou, in Fl. Reipubl. Popularis Sin. 10 (2): 10. 1997. *Type species*: *Diandranthus nudipes* (Griseb.) L. Liou, in Fl. Reipubl. Popularis Sin., 10 (2): 15. 1997.

Herbs, perennial. Rhizomes short, with lustrous scales. Nerves of scales many, prominent. Culms erect from base, terete, nodes smooth or pubescent. Leaf sheath basally glabrous, apically hairy, collar pilose or occasionally glabrous. Ligule truncate, obtuse, dentate, margin rarely ciliate. Leaves linear to linear-lanceolate, flat, herbaceous, gradually tapering at both ends, margins scabrous, apex acuminate, sparsely pilose or glabrous. Inflorescences panicles, long exserted, corymbiform, bearing several racemes on a short axis. Axis densely long pilose or glabrous in and under panicle. Racemes branched or not, rachis glabrous, flattened. Pedicels of paired spikelets unequal, compressed, margins glabrous, scabrous or ciliate. Spikelets lanceolate, dorsiventrally compressed, apex gradually attenuate, herbaceous or coriaceous, light yellow to light yellowish-brownish, occasionally with magenta spots. Callus hairs numerous, yellow, white or purple on dried specimens, 1/5 to three times as long as spikelet, falling with spikelet. Lower glume lanceolate, chartaceous, shorter than or equaling upper glume, slightly 2-keeled apically, margins folded, glabrous or pilose on folded margins rarely or densely so between keels, gradually tapering to apex, apex truncate, obtuse, emarginate, attenuate, acute or obtuse, margins of apex dentate or ciliate. Upper glume lanceolate, chartaceous, gradually attenuate to apex, apex acute, attenuate or obtuse, glabrous or slightly hairy abaxially. Lower floret sterile, without palea; sterile lemma lanceolate, membranaceous, hyaline, tapering to acute apex. Upper floret fertile, hermaphroditic. Fertile lemma

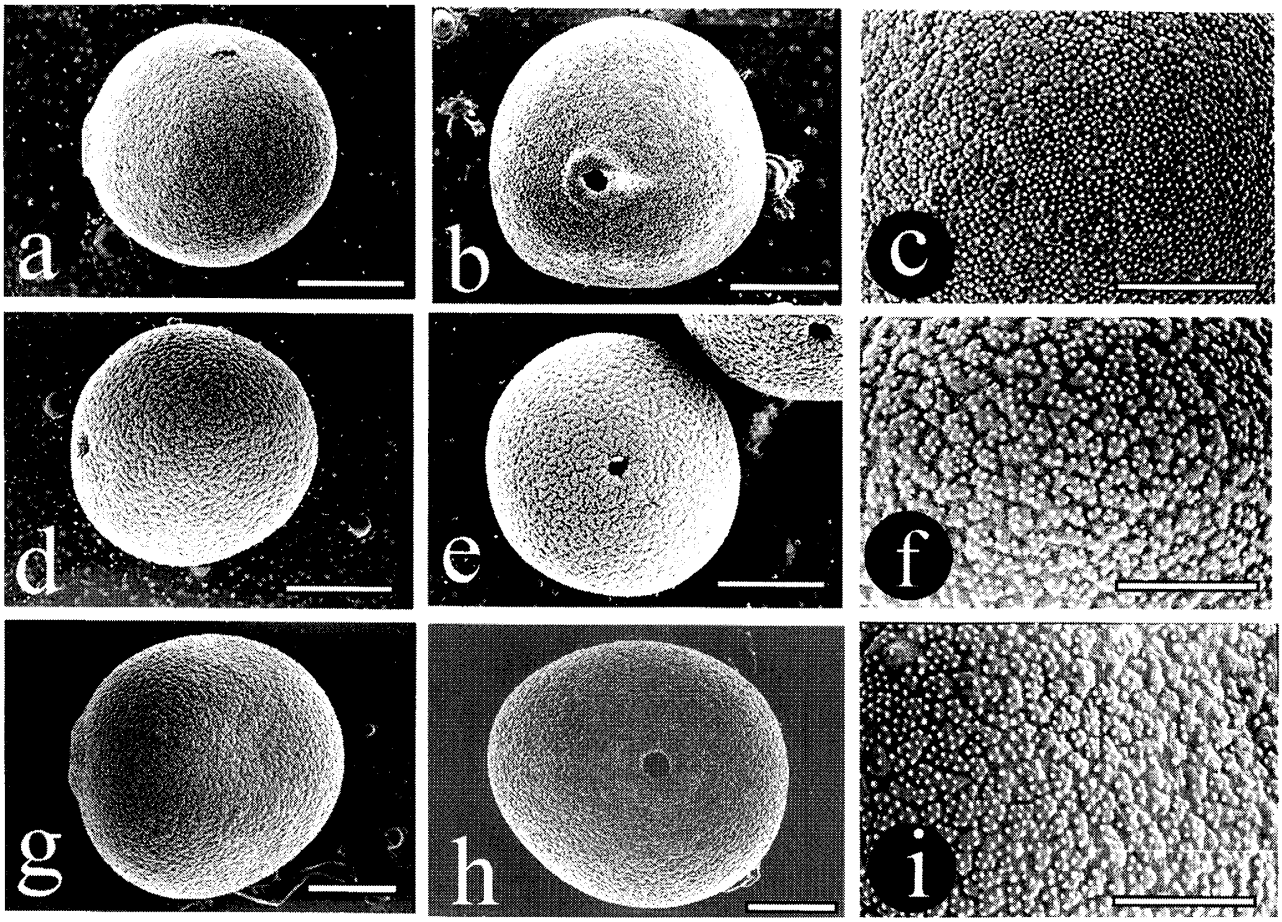

FIG. 9. SEM photographs of pollen grains of *Diandranthus* and its related taxa. a-c. *D. nudipes* subsp. *nudipes* (*Naito et al. 1012*, TUS); d-f. *D. nepalensis* (*Mikage et al. 9682755*, TUS); g-i. *M. sacchariflorus* (*Yonekura 1147*, TUS). bar = 10μm in a, b, d, e, g, h. bar = 5μm in c, f, i.

lanceolate, hyaline, nerve 1, apex acute, attenuate or bifid, awn straight, bent or geniculate, scaberulose. Palea lanceolate, hyaline. Lodicules 2 or absent. Stamens 2, anthers orange, brown or purple. Styles 2, stigma plumose, purple, exserted from apex of spikelet.

Distribution: CHINA, NEPAL, INDIA and MALAY PENINSULA.

1. Diandranthus nudipes (Griseb.) L. Liou [in C. Y. Wu, Fl. Xizang. 5: 312. 1987. comb. invalid.; in W. T. Wang *et al.*, Vasc. Pl. Hengduan Mts. 2: 2298. 1994. comb. invalid.] in S. L. Chen, Fl. Reipubl. Popularis Sin. 10 (2): 15. 1997. - *Erianthus nudipes* Griseb. in Nachr. Königl. Ges. Wiss. Georg-Augusts-Univ. 1868: 92. 1868. - *Miscanthus nudipes* (Griseb.) Hack. in A.DC., Monogr. Phan. 6: 109.

Key to taxa

1. Hairs of callus shorter than spikelet; spikelets 3-6 mm long ..... 1. *D. nudipes*
   2. Callus hairs 1-5.5 mm long, usually equaling spikelet; axis of panicle hairy or occasionally glabrous ..... 1-1. *D. nudipes* subsp. *nudipes*
   2. Callus hairs 0.1-3 mm long, usually 1/4-1/5 as long as spikelet; axis of panicle glabrous ..... 1-2. *D. nudipes* subsp. *yunnanensis*
1. Hairs of callus three times longer than spikelet; spikelets 2-3.5 mm long ..... 2. *D. nepalensis*

1889; Hook. f., Fl. Brit. Ind.: 107. 1897; Keng in Fl. Ill. Pl. Prim. Sin. Gramineae: 754. 1959; Bor, Grasses Burma, Ceylon, India & Pakistan: 196. 1960; Y. N. Lee in J. Jap. Bot. 39 (10): 297. 1964; Moulik, Grasses & Bamboos India 1: 315.1997. - *Type*: Sikkim. 9-13000 feet, *J. D. H* [*ooker*], *10* (Holotype GOET !; Isotype K !, Fig. 10)

1-1. Diandranthus nudipes (Griseb.) L. Liou subsp. **nudipes**

Miscanthus taylorii Bor in Kew Bull. 8: 273. 1953; Bor, Grasses Burma, Ceylon, India &

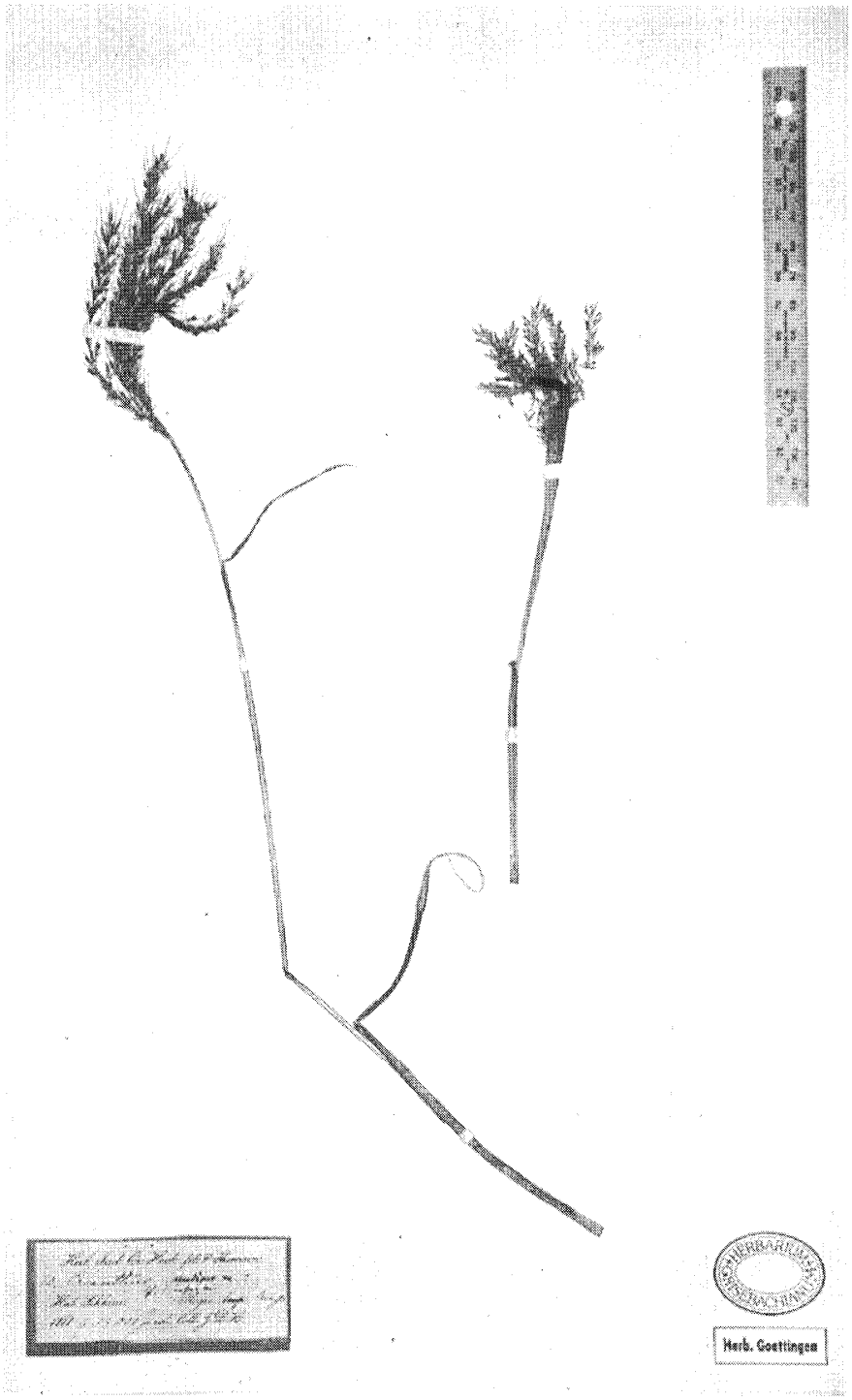

FIG. 10. Holotype of *Diandranthus nudipes* (Griseb.) L. Liou subsp. *nudipes*

Pakistan: 196. 1960; Y. N. Lee in J. Jap. Bot. 39 (10): 297. 1964 - *Miscanthus nudipes* (Griseb.) Hack. subsp. *taylorii* (Bor) Y. N. Lee in J. Korean Pl. Taxon 3: 18. 1971; Moulik, Grasses & Bamboos India 1: 315. 1997. - *Diandranthus taylorii* (Bor) L. Liou [in C. Y. Wu, Fl. Xizang. 5: 310. 1987. comb. invalid.] in S. L. Chen, Fl. Reipubl. Popularis Sin. 10 (2): 14. 1997. *Type*: CHINA, S. E. Tibet, Kongbo Prov.,Tum La, Nayu, 11,000ft., Common in open swampy meadow 2-3ft high., *E. Ludlow, G. Sherriff & G. Taylor 5799* (Holotype: BM !)

Miscanthus wardii Bor in Kew Bull. 8: 274. 1953; Bor, Grasses Burma, Ceylon, India & Pakistan: 196. 1960. - *Miscanthus nudipes* (Griseb.) Hack. subsp. *wardii* (Bor) Y. N. Lee in J. Korean Pl. Taxon 3: 18. 1971; Moulik, Grasses & Bamboos India 1: 315. 1997. - [*Diandranthus wardii* (Bor) L. Liou in C. Y. Wu, Fl. Xizang. 5: 311. 1987. comb. invalid.] - *Type*: Assam, Dichu gorge: Lohit valley. 4500,' *F. Kingdon - Ward 19328* (Holotype: K !)

Diandranthus corymbosus L. Liou [in C. Y. Wu, Fl. Xizang. 5: 312. 1987 nom. invalid.] in S. L. Chen, Fl. Reipubl. Popularis Sin. 10 (2): 16. 1997. - *Type*: Xizang, Nyingchi, 3200 m, *G. W. Chang 87* (Holotype: PE n.v.)

Diandranthus tibeticus L. Liou [in C. Y. Wu, Fl. Xizang. 5: 308. 1987 nom. invalid.; in W. T. Wang et al. Vasc. Pl. Hengduan Mts. 2: 2296. 1994 nom. invalid.] in S. L. Chen, Fl. Reipubl. Popularis Sin. 10 (2): 13. 1997. - *Type*: Xizang: Bomi Xian, Tang mai along the Bo tou fu bu River 2080 m., *T. S. Ying et D. Y. Hong 650779* (Holotype: PE !).

Roots 2 mm thick. Culms 20-140 cm tall, 2-8 mm thick. Leaf sheath basally glabrous, apically hairy, hairs white, 2 mm long; collar densely pilose. Ligule 1-1.5 mm long, truncate, chartaceous, margin dentate. Leaves linear, 6-35 cm long, 2-15 mm wide, midvein prominent, both surfaces sparingly pilose, hairs soft, 4 mm long. Panicle 5-19 cm long, 1-10 cm wide, bearing 3-15 racemes on a short axis. Axis 2-8.5 cm long, densely long pilose or glabrous in and below panicle. Racemes 5-13 cm long, unbranched. Pedicels of paired spikelets unequal, 2.8-5 mm and 1-2.5 mm long respectively. Spikelets 3-6 mm long excluding awn, 1-1.2 mm wide, herbaceous, light yellowish brown with magenta spots. Callus hairs 1-5.8 mm long, ca. 4/5 as long as spikelet (Fig. 5a). Lower glume 2-7-nerved, folded margins and rarely between keels pilose, hairs 1-3.5 mm long, apex acute or obtuse, edge ciliate, shorter than or equaling upper glume. Upper glume 1-3-nerved. Sterile lemma 3.5 mm long, without distinct nerves, upper margins ciliate. Fertile lemma 3.5 mm long, apex acute, slightly ciliate on upper margins, awn 5-15 mm long, straight. Lodicules 2, truncate, ca. 0.5 mm long. Anthers 1.7-2.2 mm long, orange, brown or purple. Stigmas ca. 2 mm long.

Distribution (Fig. 11): eastern NEPAL (ca. 3500 m), Sikkim (2640-2800 m), Assam (ca. 1500 m), BHUTAN (2700-3000 m), CHINA (1950- 3600 m).

Notes: The following are conspecific with *Diandranthus nudipes* subsp. *nudipes*.

1) *Miscanthus taylorii* was distinguished from *Diandranthus nudipes* by differences in the shape of the apex of the lower glume (Bor 1953, 1960, Liou 1997). Lee (1971), however, noted that the shape of the apex of the lower glume varies even within an individual and it is impossible to use as a taxonomic character.

2) *Miscanthus wardii* was separated from its congeners by the glabrous lower glume, the truncate apex of the lower glume and spikelets as long as, or longer, than the rachis internode (Bor 1953, 1960). Those differences represent intraspecific variation within *Diandranthus nudipes* subsp. *nudipes* (Fig. 3).

3) *Diandranthus tibeticus* was noted by Liou (1987) to have "spiculae 5(-6) mm longae," "arista 10-15 mm longa" and "*D. nudpedi* (Hack.) L. Liou comparanda sed ab eo spiculae gluma inferiore apice acuta, glabra, aristis longioribus..." I have

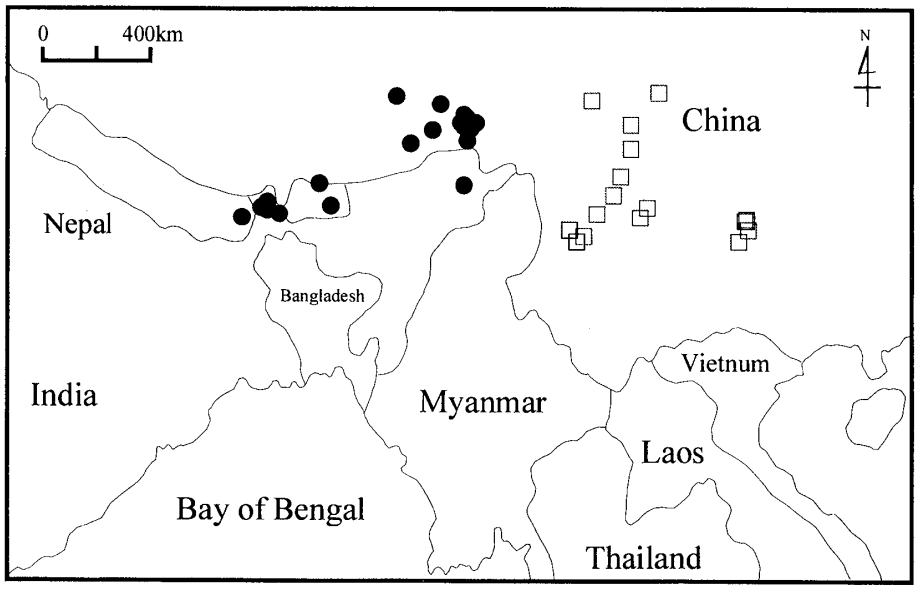

FIG. 11. Distribution map of *Diandranthus nudipes* and subsp. *yunnanensis*. ●= subsp. *nudipes*; □= *subsp. yunnanensis*.

seen spikelets (Fig. 4) and awns (Fig. 7) as large on many specimens throughout the range of *D. nudipes* subsp. *nudipes* and the differences are recognized as intraspecific variations. I therefore treat *D. tibeticus* as a synonym of *D. nudipes* subsp. *nudipes*.

4) *Diandranthus corymbosus* was distinguished from *D. nudipes* on the size of the spikelets and length of the callus hairs (Liou 1987), but such variation in these characters can be seen in *D. nudipes* subsp. *nudipes* (Figs. 4, 6).

1-2. Diandranthus nudipes (Griseb.) L.Liou subsp. **yunnanensis** (A.Camus) Ibaragi **comb. nov.** - *Miscanthus nudipes* (Griseb.) Hack. subsp. *yunnanensis* A. Camus in Bull. Mus. Hist. Nat. Paris 25: 670. 1919. - *Miscanthus yunnanensis* (A. Camus) Keng in Sinensia 10 (1/6): 290. 1939. - *Diandranthus yunnanensis* (A. Camus) L. Liou in S. L. Chen, Fl. Reipubl. Popularis Sin. 10 (2): 14. 1997. - *Type*: CHINA: Yunnan, collines arides _ Tong-chouan, 2500-2600 m., annèe 1914, *E. E. Maire*. (Isotype: P !, Fig. 12)

Miscanthus brevipilus Hand.-Mazz. in Symb. Sin. 7: 1306. 1936; Keng, Fl. Ill. Pl. Prim. Sin. Gramineae 751-752. 1959; Y. N. Lee in J. Jap. Bot. 39 (10): 297. 1964. - *Diandranthus brevipilus* (Hand.-Mazz.) L. Liou [in W. T. Wang *et al.* Vasc. Pl. Hengduan Mts. 2: 2297. 1994. comb. invalid.] in S. L. Chen, Fl. Reipubl. Popularis Sin. 10 (2): 16, 18. 1997. - *Type*: CHINA, northwestern Yunnan, Föhrenwälder der tp. St. am Hange des Waha bei Yungning, 3200 m, H. F. *v. Handel - Mazzetti 7073*. (Holotype: WU !)

Miscanthus eulalioides Keng in Sinensia 10 (1/6): 288. 1939; Keng, Fl. Ill. Pl. Prim. Sin. Gramineae 752-753. Fig. 696. 1959; Y. N. Lee in J. Jap. Bot. 39 (10): 296. 1964. - *Diandranthus eulalioides* (Keng) Liou [in W. T. Wang *et al.* Vasc. Pl. Hengduan Mts. 2. 2297. 1994. comb. invalid.] in S. L. Chen, Fl. Reipubl. Popularis Sin. 10 (2): 15. 1997.- *Type*: CHINA, Yunnan, eastern slopes of Likiang Snow Range, Yangtze watershed, *J. F. Rock 10832* (Holotype: US, Photo TKPM !)

Miscanthus szechuanensis [Keng in Keng, Fl. Ill. Pl. Prim. Sin. Gramineae 754. 1959. nom. nud.; Y. N. Lee in J. Jap. Bot. 39 (10): 297. 1964. nom. nud.] ex Zhong in J. Southwest Agric. Coll. 1(4): 80-81. 1982; [*Diandranthus szechuanensis* (Keng ex Zhong) L. Liou in W. T. Wang *et al.* Vasc. Pl. Hengduan Mts. 2. 2297. 1994. comb. invalid.] -

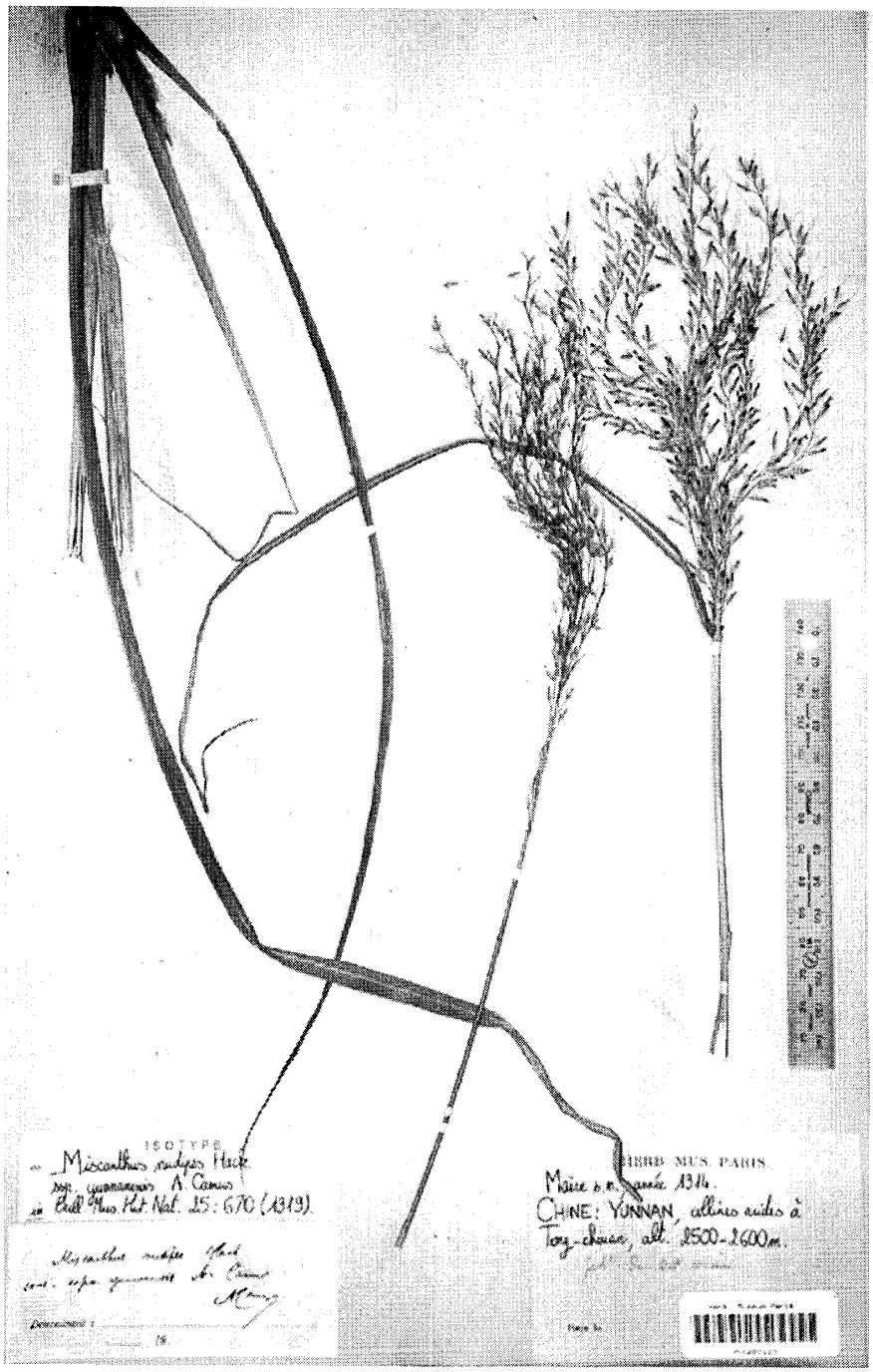

FIG. 12. Isotype of *Diandranthus nudipes* (Griseb.) L. Liou subsp. *yunnanensis* (A. Camus) Ibaragi

Type: Sichuan. Leibo Xian, 1500 m. *T. T. Yü, 3507* (Holotype: PE, n.v.)

[*Diandranthus aristatus* L. Liou. in Pl. Res. Gram. 11: 18. 1989. nom. invalid. ut *Diandranthus aristidus*; L. Liou in W. T. Wang *et al.* Vasc. Pl. Hengduan Mts. 2: 2297. 1994. nom. invalid.; Liou in S. L. Chen, Fl. Reipubl. Popularis Sin. 10 (2): 18. 1997. nom. nud.] - Type not designated but the locality is cited as 'Sichuan, Daofu' in Fl. Reipubl. Popularis Sin. 10 (2): 17-18. 1997.

Roots 1.5-1.8 mm thick. Culms 50-150 cm tall, 5-7 mm thick at the base. Ligule 1-1.8 mm long, obtuse, margin occasionally ciliate. Leaves 23-

50 cm long, 4-9 mm wide, abaxial surface sparingly pilose with long soft hairs, adaxial surface glabrous or occasionally sparingly pilose. Panicle 8.5-19 cm long, 2-10 cm wide, bearing 5-11 racemes on short (2.5-10 cm long) axis. Axis glabrous in and below panicle. Racemes 4-12 cm long. Pedicels of paired spikelets unequal, 3-5 mm long, 0.8-4 mm long respectively, glabrous or margins occasionally ciliate. Spikelets 3.2-6 mm long excluding awn, 0.8-1 mm wide, light yellowish-brown. Callus hairs white on dried specimens, 0.1-3 mm long, longer on adaxial surface, ca. 1/4-1/5 as long as spikelet (Fig. 5b). Lower glume 3-5 nerved, densely pilose on folded margins and between keels, hairs 2-4.7 mm long, apex obtuse, acute or attenuate, edges usually dentate, margin membranaceous and ciliate, shorter than upper glume. Upper glume usually single nerved, abaxially hairy. Sterile lemma ca. 3.8 mm long. Fertile lemma 3.5 mm long, apex attenuate or bifid, awn 3-14 mm long, straight, bent or geniculate. Lodicules ca. 0.4 mm long. Anthers 2.5 mm long, orange.

Distribution (Fig. 11): CHINA. Guizhou (1000-1500 m), Sichuan (1600-3100 m), Yunnan (2500-2900 m).

Notes: *Diandranthus nudipes* subsp. *yunnanensis* and subsp. *nudipes* have been treated as separate species based on differences in callus hair length and hairiness of the inflorescence axis (Keng 1957, Zhong 1982, Liou 1997), but those characteristics are variable and there is no discontinuity (Figs.2, 5d, 6). Since they are geographically separated from each other, however, but are continuous in their diagnostic characteristics, they are best treated as subspecies of *Diandranthus nudipes*.

Four names are placed in synonymy under *Diandranthus nudipes* subsp. *yunnanensis*.

1) *Miscanthus szechuanensis*. In the protologue, Zhong (1982) separated *M. szechuanensis* from *D. nudipes* on the basis of the small spikelets (4 - 4.5 mm long) and glabrous inflorescence axis. These characters are congruent with the diagnostic features of *D. nudipes* subsp. *yunnanensis* (Figs. 2, 4).

2) *Miscanthus eulalioides*. Keng (1939) reported this species to have much larger spikelets than *M. brevipilus* (= *D. nudipes* subsp. *yunnanensis* in this paper). The spikelet length of the latter, however, shows considerable variation (Fig. 4) and the difference is within the range of variation of subsp. *yunnanensis*.

3) *Miscanthus brevipilus* was distinguished from *Diandranthus nudipes* subsp. *yunnanensis* by its geniculate awns and short culms (Handel-Mazzetti 1936, Zhong 1988). Those characteristics in the latter vary greatly and the differences are within the range of variation of the subspecies. Because of this, *M. brevipilus* should be treated as a synonym of *D. nudipes* subsp. *yunnanensis*.

4) *Diandranthus aristatus*. Liou (1994, 1997) reported *D. aristatus* as having two awns per spikelet, but this characteristic is variable and cannot be used diagnostically for any of the species of *Diandranthus*. Additionally, the specimen, *T. S. Ying 9517* cited by Liou (1994), does not have spikelets with two awns.

2. Diandranthus nepalensis (Trin.) L. Liou [in C. Y. Wu, Fl. Xizang. 5: 313. 1987. comb. invalid.; L. Liou in W. T. Wang *et al.* Vasc. Pl. Hengduan Mts. 2: 2298. 1994. comb. invalid.] in S. L. Chen, Fl. Reipubl. Popularis Sin. 10 (2): 10, 13. 1997. (Fig. 13). - *Eulalia nepalensis* Trin. in Mém. Acad. Imp. Sci. St. Pétersbourg, Sér. 6, Sci. Math. vol. 2: 333. 1833; Grisebach in Nachr. Königl. Ges. Wiss. Georg-Augusts-Univ. 3: 93. 1868. - *Miscanthus nepalensis* (Trin.) Hack. in A.DC., Monogr. Phan. 6: 104-105. 1889; Hook. f. Fl. Brit. India 7: 107. 1897; Rendle in J. Linn. Soc., Bot. 36: 347. 1904; Keng, Fl. Ill. Pl. Prim. Sin. Gramineae 754, Fig. 1095. 1959; Bor, Grasses Burma, Ceylon, India & Pakistan: 196. 1960; Y. N. Lee in J. Jap. Bot. 39 (10): 297. 1964; Gilliland, Fl. Malaya 3: 218. 1971; Moulik, Grasses & Bamboos India 1: 315.1997. -

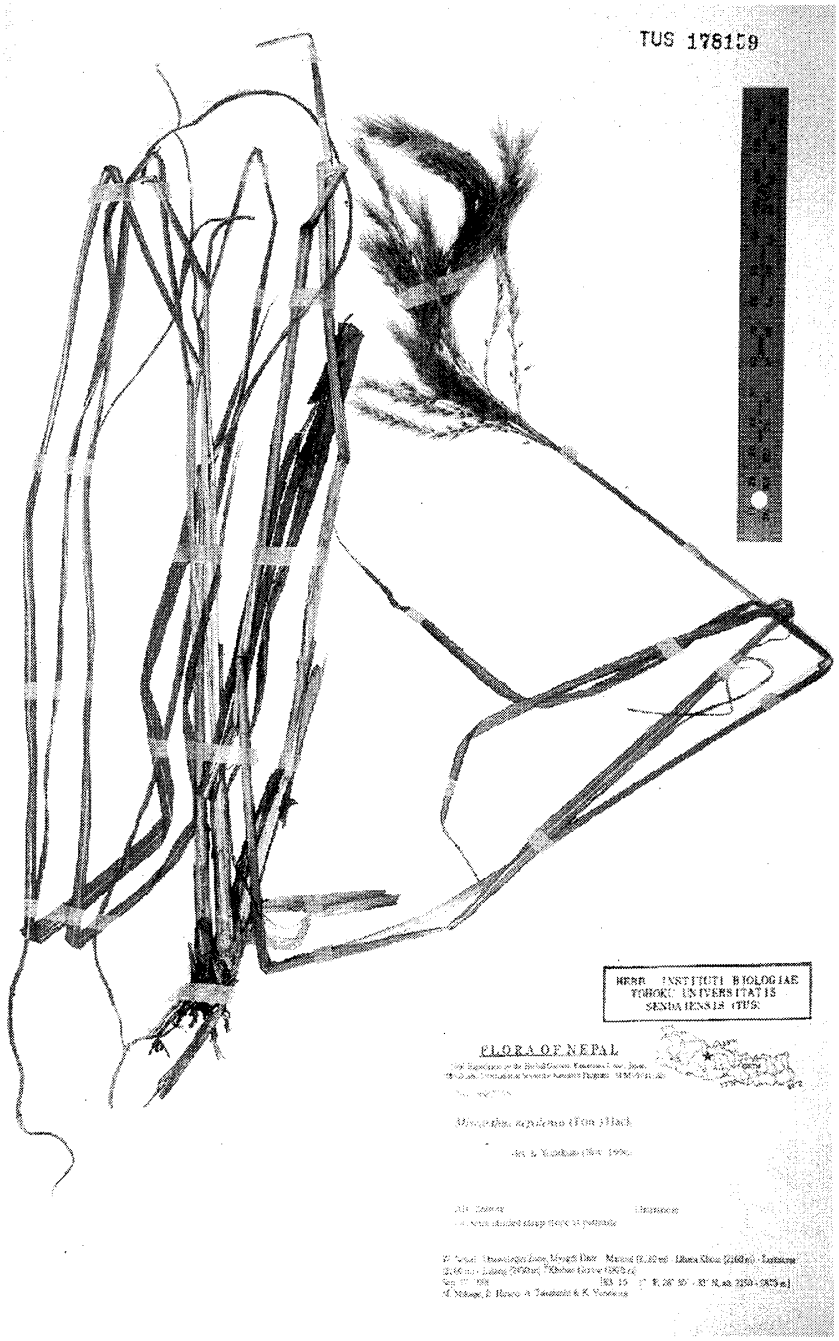

FIG. 13. *Diandranthus nepalensis* (Trin.) L. Liou

Type: V. sp. NEPAL. (Holotype: LE ?, n.v.)

Culms 30-160 cm tall, 2-10 mm thick, smooth; nodes glabrous. Ligules 2-4 mm long, truncate or obtuse. Collar densely hairy (hairs 2-4 mm long) or occasionally glabrous. Leaves linear-lanceolate, 15-58 cm long, 5-10 mm wide. Panicle 10-19 cm long, 6-10 cm wide, bearing 5-30 racemes on short axis. Axis 2.5-12 cm long, glabrous or occasionally densely pilose below panicle (hairs 2-4 mm long). Racemes 8-12 cm long. Spikelets paired, on unequal pedicels. Pedicels 2-5 mm and 1-3 mm long respectively, margins scabrous. Spikelets 2-3.5 mm long, 0.5 mm wide, coriaceous, light yellow. Callus hairs yellowish, 7-10 mm long, three time as long as spikelet (Fig. 5c). Lower glume 5-nerved,

glabrous abaxially, margins ciliate. Upper glume 1-nerved, glabrous. Sterile lemma 2.5 mm long, 1-nerved or without distinct nerve. Fertile lemma 2.3 mm long, apex bifid, awn 4-14 mm long, straight. Lodicules absent. Anthers ca. 1.5 mm long, orange. Stigma ca. 1.8 mm long.

Distribution: BHUTAN (1750-2200 m), NEPAL (1300-2800 m), India (1600-2000 m), CHINA (2100-2600 m), Sichuan (1200-2300 m), Yunnan (2000-2700 m), MALAYSIA. (Fig. 14.)

Doubtful species

Diandranthus ramosus L. Liou [in C. Y. Wu, Fl. Xizang. 5: 310. 1987. nom. invalid. - in W. T. Wang *et al.*, Vasc. Pl. Hengduan Mts. 2: 2297.1994 nom. invalid.] in S. L. Chen, Fl. Reipubl. Popularis Sin. 10 (2): 11. 1997. - *Type*: CHINA, Xizang: Zayu, 2000 m, *G. W. Chang 620* (Holotype PE n.v.).

Diandranthus ramosus L.Liou was separated from its congeners by its characteristic branching culms (Liou 1987, 1994, 1997). In the original description, it is also described as having callus hairs as long as the spikelets. It is restricted to Xizang, China. Based on this information, I believe it may be a variant of *D. nudipes*, but I cannot be certain because I have not seen specimens of it.

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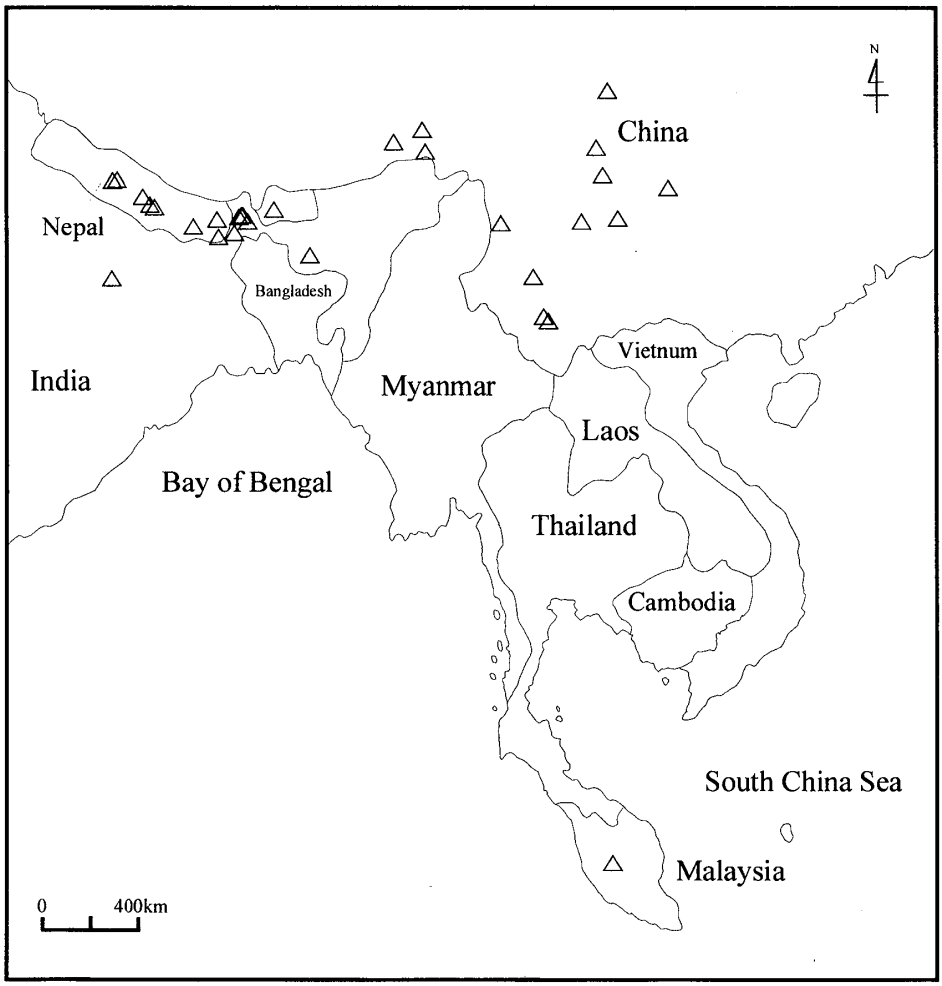

FIG. 14. Distribution map of *Diandranthus nepalensis*.

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Appendix

Additional specimens examined

Diandranthus nudipes (Griseb.) L. Liou subsp. **nudipes** CHINA. **Xizang**. Asaimu, *B. Q. Zhong 6032* (PE); Bomi, Gu xiang. 2900 m. *T. S. Ying* & D. Y. Hong 650163 (PE); Dichu Valley. Layul, F. Kingdon-Ward 15024 (E); Feng qu. 2600 m. Collector unknown 429 (PE); Lhuuli, R. E. Cooper 252 (E, TNS); Mi lin, B. Q. *Zhong* 7143 (PE); Ni ma, B. Q. *Zhong* 7043 (PE); North of Yiong Zhang bo liver. 2200 m. *T. S. Ying & D. Y. Hong 650710* (PE); Bomi Xian: Tang mai ca. 2000 m. *T. Naito et al. 1012*

(TUS); Bomi Xian, Jia *Zhong* Ka. 2400 m. *B. Q. Zhong 6572* (PE); Bomi Xian, Tang mai. *T. S. Ying & D. Y. Hong 650101* (PE); Bomi Xian, Tang mai. 2100 m. *Y. T. Zhang & J. Y. Lang 808* (PE); Bomi Xian, Tang mai 1950 m. *T. S. Ying & D. Y. Hong 650096* (PE); Bomi Xian. 3100 m. *B. S. Li, Z. C. Xian & S. Z. Cheng 6573* (PE); Linzhi Xian. 3500 m. *Xizang zhong cao yao pu cha exped. 3299* (PE); Motou Xian. *V. S. Li & S. Z. Cheng 03881* (PE); Trulung, Po-Tsangpo valley. 6500ft. *Collector unknown 12367* (E); Yigrong Gorge, Tsangpo valley. 11000ft. *F. Kingdon-Ward 12207* (E).

BHUTAN. Sengor, NW of Mongar. 3000 m. *A. J. C. Grierson & D. G. Long 2517* (E, TI); Sharithang to Amo Chu. 2700 m. *S. Nakao 734* (KYO); Yuto La. 2800 m. *S. Nakao 284* (KYO).

INDIA. **North district.** Bicchu S of Lachung. On cliff by road. 2640 m. *D. G. Long & H. J. Noltie 131* (E). **Sikkim**. Lachung to yuerthang road. 2800 m. *S. Kueanar & P. Singh 9575* (BSHC); Thansu-Gompa, North Sikkim. *D. C. S. Raju & S. Singh 6211* (BSHC).

NEPAL. Arun valley: Maghang Khola. E. of Num 10500ft. *J. D. A. Stainton 801* (BM, E).

Diandranthus nudipes (Griseb.) L. Liou subsp. **yunnanensis** (A.Camus) Ibaragi

CHINA. **Guizhou.** Hua xi. 1500 m. *Z. Y. Cao 0174* (PE); Liang Feng Yah, Tsunyi Hsien. 1100 m. *A. N. Steward, C. Y. Chiao and H. C. Cheo 209* (PE); Zun yi. *Collector unknown 1108* (PE); Zun Yi. *Chuang Quan exped 1105* (PE); Zun Yi. *Chuang Quan exped 1108* (PE); Zun yi, Mt. Nan qian. 1000 m. *Chuan qian exped. 980* (PE). **Sichuan**. *Collector unknown 2572* (PE); *Chuan kang exped. 3069* (PE); along the Hei shui niao liver. 3200 m. *X. Li 73189* (PE); austro-occid.: In altiplanitiei ad oppidum Yenyuan regione calide temperata. 2600 m. *H. F. v. Handel - Mazzetti 2865* (WU); Da jin Ka sa, Luo quan gou. 2700 m. *X. Li 77901* (PE); Gan zi zhou. *T. S. Ying 9517* (PE); Jiu long 3100 m. *T. S. Ying 4879* (PE); Li mi. *C. L. Wu 33693* (PE); Li mi da gou. *C. L. Wu 33505* (PE); Lu ding 1800 m. *Chuan xi exped. 1769* (PE); Luding Xian. *West-Sichuan Exped. 6904* (PE); Ma ya. *Yu & Liou Aug. 1941* (PE); Muli Xian Mt. Bi luo ge. 3400 m. *T. S. Ying 4231* (PE); Poge, Da Cao he. 1600 m. *Collector unknown 14196* (PE); Zhao jue. 2100 m. *Collector unknown 12753* (PE). **Yunnan.** Li Jiang. 2800 m. *Dian Xi exped. 4575* (PE); Li Jiang, Mt. Wang long. 2900 m. *Beijin exped. 02686* (PE); Ninglang Xian, Ci ba ping. 2500 m. *S. Jiang 6132* (PE).

Diandranthus nepalensis (Trin.) L. Liou

MALAYSIA. Just behind the army camp Cameron Highlands. Pahang. *M. Kassim 465* (BISH).

CHINA. **Sichuan.** Bao xing cheng. 1200 m. *Chuan xi exped. 2585* (PE); Bao xing. 2300 m. *K. C. Kuan & W. T. Wang 2998* (PE); E mei shan. *K. C. Kuan et al. 1896* (PE); E mei shan. 4500-5000ft. *W. P. Fang 3192* (PE); Jin Yang, *Collector unknown 13476* (PE); Nan chuan. 1600 m. *J. H. Xiong & Z. L. Zhou 93057* (PE); Pu ge, *Chuan xi exped. 5548* (PE); Sung pang. *W. P. Fang 4185* (PE). **Xizang.** 2450 m. *Qing hai - Xizang exped. 2534* (PE); 2600 m. *Zhou 726* (PE); between Lu lang and tang mai. *Y. T. Zhang & K. Y. Lang. 2797* (PE); Lin Zhi. 2300 m. *B. S. Li & S. Z. Cheng 01914* (PE); Mo tou Ge dang qu. 2100 m. *B. S. Li & S. Z. Cheng 01000* (PE) **Yunnan.** Da guan. 1750 m. *Diang dong bei exped. 478* (PE); Da li. *H. C. Wang 14495* (PE); Da li. *H. C. Wang 1449* (PE); Da li. *H. C. Wang 1255* (PE); Gong shan, *Qing zhi exped. 9717* (PE); Hill to north-east of Yengyueh. 8000ft. *G. Forrest 9291* (PE); Mt. Wu liang. 2500 m. *B. Y. Qiu 53425* (PE); Mt. Zhang yao. 2550 m. *B. Y. Qiu 53751* (PE); Shang-pa. 2000 m. *H. T. Tsai 58990* (PE); Shang-pa. 2000 m. *H. T. Tsai 56565* (PE); Shang-pa. 2500 m. *H. T. Tsai 54447* (PE); Soo-roo-la, Cham-pu-tung. 2500 m. (C. W. Wang 66636 PE).

BHUTAN. Between Kyapcha Dzong and Similaca. 2100 m. *S. Nakao 630* (KYO); Thimbu 2200 m. *S. Nakao 827* (KYO); Tinkegang. 1750 m. *H. Kanai et al. 1327* (TI).

INDIA. Darjeeling, *T. Tateoka 286* (TI); Darjeeling. Kurseon. 1600 m. *M. Togashi 20556* (TI); Darjeeling Batassi - Palmajua. 2300-2600 m. *H. Kanai et al. 20577* (TI); Darjeeling. *T. N. Liou 6431* (PE); Khasia & Jaintia hills, Shillong peak ca. 6000ft. *D. Mitra 71* (TUS, TI). **Sikkim.** East Dist. Phadamchen. *B. Krishna & B. Mitra 6668* (BSHC); Gantok East Himalaya *K. Biswas 9771* (PNH); Soreng to Chakung. *P. Singh 15391* (BSHC); Balwakhani near Govt. of India Press. Gangtok. *P. K. Hajra 554* (MAK).

NEPAL. Between Sikha and Chitre, Myagdi district. *H. Tabata et al. 6573* (KYO, Herbarium of Tamagawa University); Damchan 2200 m. *K. R. Rajbhandari & K. J. Malla 6482* (TI); Sailabara gaon near Tibriko Dolpo District. 2575m, *H. Tabata et al. 3392* (Herbarium of Tamagawa University); Thanchok - Dhanagyung 2400 m. *K. R. Rajbhandari 8985* (TI). **Central Nepal.** Bagmati zone Lalitpur & Kabhrepalanchok Distr.: camp site, N. ridge of Mt. Phulchoki 2130 m, - ca. 1km NW of Mt. Phulchoki 2480 m - Godawari 1540 m, *M. Mikage et al.*

9552699 (TUS); Between Trisuli and Shabru, *H. Tabata et al. 9329* (Herbarium of Tamagawa University); Jhose. 6000ft. *Banerjes Shrestha & Upadhyay 3061* (KATH); Kagonei. 2830 m. *N. P. Mamandha 10199* (KATH); on the way to Tanglung. ca. 8000ft. *Shresta & Bista 2395* (KATH); Phulchoki 7000ft. *P. Pràlhan 4263* (KATH); Phulchoki 9500ft. *Ram Bahadur & Radha Krishna 17891* (KATH); Pikhal danda. 6500ft. *P. R. Shakya & K. R. Rajbhandari 3377* (KATH); Putali danda. S of Kathi. 1900 m. *Joshi Rajbhandari & Guimire 751140* (KATH); Tham danda. 2190 m. *Joshi Rajbhandari & Glumire 751145* (KATH). **East Nepal.** Baroya Khimty - Thakma Khola, *H. Hara et al. 6302322* (TI); Bhuspate Danda - Bhandukay Banjang - Mai Majuwa *H. Hara et al. 6302326* (KYO); Dhankuta - Hilay, *H. Hara et al. 6302317* (TI); Iram to Maipokuari 6600ft. *P. Praduan et al. 250* (KATH); Minchin Dhap - Mul Pokhari, *H. Hara et al. 6302319* (TI); Namikhil 2300 m - Chamare 1900 m - Likhu 1550 m. - Bhandar 2300 m. *H Ohba et al. 62258* (TI); near Chyangthaphu - Chyangthaphu - Birwa. ca. 1000 - 2000 m. *H. Kanai et al. 6302324* (TI); near Tapetok 1300 m *K. Nishioka 1101* (KYO); Sinduwa 2100 m. *M. Togashi & T. Tuyama 6302318* (KYO, TI); Tapejung - Heydewa - Garhi Danra, *H. Hara et al. 6302320* (KYO, TI); Tharpu - near Chyangthaphu, *H. Kanai et al. 6302323* (KYO, TI); Tuwa - Kiwa -Taplethok, *H. Hara et al. 6302321* (KYO, TI); Yektin - Akasay - Batasay. ca. 1500 - 2000 m. *H. Hara et al. 6302325* (TI). **N. E. Nepal.** Eastern flanu & Buje Danda. 2500 m. *Mike Sinnott et al. 1230* (KATH). **W. Nepal.** Dhawalagiri zone, Myagdi Distr., Ghorepani - Chitre - Sikha - Ghara - Tatopani. 2210 m. *M. Mikage et al. 9552226* (TUS); Myagdi. Lulang - Khaban Gurase. 2800 m. *M. Mikage et al. 9682755* (TUS).

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